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## TEACHING PRACTICAL MATHEMATICS EFFICIENTLY.

BY CHARLES H. SAMPSON.

Practical mathematics is a valuable tool for any tradesman to own. And yet a very small percentage indeed of these men fully realize the value of this tool. *Why?*

There are several reasons, apparently, why there is not the proper conception of the value of practical mathematics as a part of one's equipment. These may be enumerated as follows:

1. Too many tradesmen are satisfied to remain cogs in the industrial machine of which they are a part. A day's work to them means running a machine and what they get for doing it. Nothing more. They are not interested in adding another tool to the kit which seems to them sufficiently complete to enable them to obtain what they are satisfied to obtain. These men belong to the non-ambitious class. Many of them could never appreciate the value of this suggested tool.

2. But there are some mechanics that seem to realize that after all there is something worth thinking about in the suggestion that they devote some time to a study of the subject of practical mathematics. This group is unfortunate in some respects. They know that they need something of this sort but they don't know what they need. They may possibly have no one to advise and guide them.

3. And then there is a third group composed of men who not only fully realize the assistance that the tool—practical mathematics—can be to them but who know, in addition to this, about what they want. These men will be the most progressive in the shop. Many of them are doubtless foreman. They will all be thinkers, more or less clean-cut in appearance; without question the best all-round men in their particular group.

It is this group of men that I wish to consider here. How can they best be taught practical mathematics effectively?

It is quite necessary that the first step be a study of existing conditions. The general subject content of the course as far as its determination is concerned, should be the result of this study. For illustration, it would not be wise to give a class of practical electricians the same problems for solution as would be presented to a class of machinists. The field must be properly surveyed and course content decided after this survey has taken place.

Now this preliminary work for the purpose as indicated does not by any means determine the total content of the course. The fact that many are inclined to think that it does, is responsible for the failure of many classes in this subject. *A great deal of emphasis should be given the fundamental mathematical processes.* I have seen it happen so many times—the assurance on the part of the members of the class that they *do know* how to add and subtract and multiply and divide. But they don't! Men of the age generally enrolled in these classes are liable to say: "I took all of that back in the grammar school and don't need it now." But they fail to fully appreciate what it really means to attempt to resurrect memories of processes usually covered in an unsatisfactory manner several years past. These things are easily forgotten unless constantly used. And they are not usually—constantly used.

So it is exceedingly important that the general content, that is, the problems to be solved, be built upon and around the usual fundamental mathematical truths.

What then should the course consist of? My experience with hundreds of students tells me that the following general outline is the best for all-round use. Note that there are twenty assignments in all. This is a good number to use for two or three sound reasons. Interest in any given year cannot be held for much longer than that; the courses would generally be offered during the late fall, winter and spring and twenty weeks (one assignment a week) is about all the time conveniently available; the subject matter can be very well covered in just about this length of time.

My idea of the assignment subjects is as follows:

Assignment 1.—The Fundamental Operations Applied to whole Numbers.

- Assignment 2.—The Fundamental Operations Applied to Fractions.
- Assignment 3.—Decimals and their Application.
- Assignment 4.—Percentage Practically Applied.
- Assignment 5.—The Solution of Simple Equations.
- Assignment 6.—Ratio and Proportion.
- Assignment 7.—Powers and Roots of Numbers.
- Assignment 8.—Solution of Formulas.
- Assignment 9.—Graphs Practically Applied.
- Assignment 10.—Introduction to Plane Geometry, Rules and Definitions.
- Assignment 11.—Mensuration of Four-sided Figures.
- Assignment 12.—Mensuration of the Triangle.
- Assignment 13.—The Solution of the Right Triangle.
- Assignment 14.—The Hexagon and Similar Geometrical Figures.
- Assignment 15.—Mensuration of the Circle.
- Assignment 16.—Common Geometrical Constructions.
- Assignment 17.—Rules and Definitions Relating to Geometrical Solids.
- Assignment 18.—Prisms and Cylinders.
- Assignment 19.—Pyramids and Cones.
- Assignment 20.—The sphere.

This outline may seem to be too academic. But the important thing is to build practical problems around it. Isn't it just as easy to illustrate the use of the formula for finding the volume of a hexagonal prism by applying it to a hexagonal bar of iron or a hexagonal nut as to think of the model as merely a geometrical solid? It certainly is possible and it must be done if the course is to be interesting and profitable to those who take it. Shop problems for machinists, electrical problems for electricians, building problems for carpenters—all requiring for their solution a knowledge of the fundamental truths. Very simple but very important.

*The instructor is such an important element in this kind of work. Any instructor positively will not do. The mere fact that one has been a successful teacher of mathematics in a high school or college does not imply in the slightest degree that he can conduct a class in practical mathematics successfully. The*

instructor should first of all be able to get down to the level of the men whom he is teaching. He must be able to talk in terms that they can understand; he must be unusually informal in his attitude as he talks although he must at all times command attention and respect. Those who teach practical subjects should at least have some understanding of how things are done in actual practice. This work is not for a dreamer or a theorist. The teacher will be much better qualified to present the subject if he has had some actual shop or field experience himself. He can then more easily appreciate the attitude of the men and can be more certain that he will "make no breaks" as he talks and explains.

Keen interest and desire for worthwhile accomplishment is a reliable asset for the teacher to possess. He who assumes the responsibility of successfully instructing in the subject must be willing to spend some time diagnosing the particular problem in hand. He will usually find an opportunity to apply treatment in the form of special problems to illustrate some point brought out during a discussion or he may find an opportunity to interpose an interesting lecture on some subject of general interest. There is ample opportunity to test one's ingenuity in this kind of work.

Definite lesson arrangements should always be given and these should be completed and passed in when they are due. An attempt should be made to promote habits of neatness by requiring that all work be neatly arranged on the paper and that everything be in ink. The instructor for his part should get the papers (well corrected) back to the students at the next meeting after their receipt and before starting on the advanced lesson he should endeavor to draw out questions on points not understood and explain the mistakes which seem most evident in the papers to be returned.

The "drawing-out questions process" is a rather difficult one to handle satisfactorily. These men do not, generally speaking, like to ask questions. My method has always been to ask the questions on the points which the corrected papers indicate are not entirely clear and direct these questions at the man whom I know does not thoroughly understand what the answer should be. In this way discussion is usually started.

Classes should always begin on schedule time and if it is necessary to close at a stated time the period should end exactly when it should end. But if conditions are such that "on occasion" a few minutes overtime can be used to advantage, advantage should be taken of it. This extra period may often prove to be the most important part of the lesson.

One of the most valuable factors in this work (at least I have found it so) is a "follow-up" of absences. If I had a class to-night for example, and John Jones and Jim Smith were absent, each of these gentlemen would receive to-morrow, a personal letter (not a form letter) from me expressing my note of the absence, the hope that their presence can be arranged for at the next meeting, and the next lesson assignment. With me, this has been an important factor in maintaining the attendance to the desired percentage.

At the close of the course a final examination may or may not be desirable. This will depend upon the grade of men in the class as a whole. Generally speaking, I do not consider it advisable. These men are not used to taking examinations and are liable to become confused. The examination mark will not be a criterion of their general knowledge of the subject.

There should always be a certificate of completion. And nothing cheap is to be considered. A small engraved certificate dignified in appearance seems to be entirely satisfactory. The presentation of these is important. They should not be mailed but exercises should be arranged and a somewhat formal program carried out. This leaves a "good taste" and a desire for future intellectual improvement. If possible, those in authority in the places of employment of the men should be present and they should take part in the exercises.

I am positive that if the above suggestions are followed success in teaching practical mathematics will result. I have seen it accomplished again and again. There is no guess work about it. It is simply the old story of having a task to do and giving the best one has to the doing of it. The right man teaching the right course will do the job and do it right.

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